theory of elliptic integrals was developed by a method the inverse of that pursued in establishing the formulæ of common trigonometry. In the latter case, the geometrical type was given—the circle—to determine the algebraical relations of its arcs. In the theory of elliptic integrals, the relations of the arcs of unknown curves are given, to determine the curves themselves; this is the principal object of the present communication.

The problem resolves itself into twelve distinct cases, depending on the magnitude of the parameter, and the sign with which it is affected; out of the discussion of these cases arise many new and important relations of elliptic integrals. It would excite little interest to give the bare enunciations of those theorems, and a mere outline of the methods by which they are established would be unintelligible. Not the least interesting of those theorems is the proposition, that it is always possible to express an elliptic integral of the first order as the sum of two elliptic integrals of the third order, with parameters which are conjugate, reciprocal and imaginary.

The author hopes, in a future communication to the Royal Society,—the present having grown under his hands beyond the limits he anticipated—among other points, to extend his researches to the case of elliptic integrals with imaginary parameters, and to show the true geometrical meaning of such expressions. It will also be shown, that imaginary expressions may be found for a logarithmic elliptic arc analogous to the well-known imaginary exponential expressions for the sines and cosines of circular arcs.

A paper was in part read, entitled, "Further Researches into the Structure, Development and Functions of the Liver." By C. Handfield Jones, M.D., F.R.S. Received November 19, 1851.

January 29, 1852.

COLONEL SABINE, R.A., Treasurer, in the Chair.

The reading of Dr. Handfield Jones' paper, "On the Structure of the Liver," was resumed and concluded.

Dr. Leidy and Professor Retzius, with Muller, Weber and Khronenberg, maintain the existence of plexuses of ducts in the parenchyma of the liver containing the cells in their tubes. Some other anatomists, especially Gerlach, believe the ducts to be prolonged into the lobules of the parenchyma, under the form of mere intercellular passages without walls.

Injections of acetate of lead in saturated solution, thrown into the ductus communis choledochus, produce appearances which seem to confirm the latter view. The author, however, believes them to be fallacious, and that the ducts really terminate, as he has described them in his former paper, by closed extremities, either rounded and even, or

somewhat irregular. Further details are given of the condition of the ultimate and penultimate ducts in the several vertebrate classes.

In the class of Fishes, the minute ducts most commonly appear as solid cylinders of soft granulous substance, in which scarce anything but some oily molecules are to be discerned; but not very unfrequently two other conditions are observed, which seem to illustrate very well the active character of the function of the duct. In the first the granulous matter exists in much smaller quantity, and the nuclei imbedded in it are consequently seen much more distinctly; their presence is thus unequivocally determined; it is shown that there is no real difference between the ducts of the fish's and those of the mammalian liver, only that the granulous matter is usually accumulated in the former more abundantly than in the latter. The presence of free nuclei in granulous matter indicates an active change to be proceeding in the part. In the second condition sometimes observed the granulous matter lies imbedded in it, a varying number of pellucid vesicles of great delicacy, but quite distinct; these testify that a process of active growth takes place in the minute ducts, and show, the author thinks conclusively, that the seminute ducts are not mere efferent canals.

Sugar was detected on two or three occasions in the livers of fishes; it seems to be absent when the organ is extremely fatty.

In the minute hepatic ducts of reptiles, the condition of the epithelium is very similar to that in fishes; the nuclei sometimes appearing with great distinctness, sometimes being obscured by much granulous matter, sometimes developing themselves into pellucid vesicles. The livers of frogs and toads almost constantly contain dark yellow masses which were formerly regarded by the author as biliary concretions, but are now considered to be only pigmentary deposits; they coexist sometimes with much diffused black matter.

The ultimate ducts have been traced recently very satisfactorily in Birds, Mammalia and Man, and the description given of them in the paper accords with the author's former account.

The development of the liver and its apparatus of ducts has been traced out in fishes and reptiles, and the following results obtained in both classes.

(1.) The liver (*i. e.* the parenchyma of the organ) is formed as an independent mass, and does not proceed as an effect from the intestine.

(2.) The gall-bladder is developed separately as a transparent vesicle, containing a clear fluid.

(3.) The gall-bladder elongates itself at one end, tends towards the intestine, and at last opens into it, while from one part of its extent hepatic ducts are developed; in the Frog the hepatic ducts seem, however, to be formed at the same time as the gall-bladder, and to be developed *pari passu* along with it. The cystic duct is lined by ciliary epithelium which plays very actively.

The examination of the process of development in the chick has confirmed, so far as it was carried, the account given in the former paper.

In Mammalia the subject of inquiry has been chiefly the following, viz. to ascertain how far there was evidence that the secretion of bile actually is effected in and by the hepatic cell, or whether its presence in them is accidental, and the bile is really and necessarily secreted by the ultimate ducts.

It is remarked that the existence of a portal vein conveying blood from the intestinal surface is coeval, not with the formation of a bile-secreting structure (for many animals have organs which secrete abundance of biliary matter without any portal vein), but with the addition of a parenchymatous mass to the biliary organ, to which mass exclusively the portal vein is distributed. It is known that the parenchyma of the liver during, and for many hours after, digestion of food, forms, from the blood supplied to it, abundance of sugar, which thus appears to be its proper secretion; and it is not proved that the hepatic cells in a healthy state contain biliary matter, though they often do in various morbid conditions. Extracts of the hepatic parenchyma tested for bile by Pettenkoffer's method, give only very imperfect and doubtful traces of the presence of biliary matter, and on the other hand the sugar formed by the parenchyma, which is found so abundantly in the blood of the hepatic vein, is absent from the bile. The case of fatty liver, as occurring either pathologically or normally, seems also to require an explanation consonant with the view to which the above facts point, for otherwise it seems impossible to understand how perfectly formed dark-green bile could be contained in the efferent channels of a gland whose tissue is a mass of oil.

The structural condition of the ultimate biliary ducts is compared to that of the epithelium of the thyroidal cavities, and the nucleated granular tissue surrounding the lacteal in a villus; and it is shown to be probable that the terminal portions of the ducts,—so far as they possess the peculiar characteristic structure, exert an active elaborating energy, by means of which bile is formed or generated out of oily, albuminous or saccharine material which surrounds,—may be said to bathe them.

February 5, 1852.

SIR JOHN F. W. HERSCHEL, Bart., V.P. in the Chair.

The following papers were read:—

1. "Discovery that the veins of the Bat's wing, which are furnished with valves, are endowed with rythmical contractility, and that the onward flow of blood is accelerated at each contraction." By T. Wharton Jones, F.R.S., Fullerian Professor of Physiology in the Royal Institution of Great Britain, &c. Received November 20, 1851.

The author finds that the veins of the bat's wing contract and dilate rythmically, and that they are provided with valves; some of which completely oppose regurgitation of blood, others only par-